

REMARKS**Claims Amendment**

Claim 13 has been amended to correct typographical error. Support for this amendment is found on page 7, line 18 of the specification as filed.

Claims 23-32 have been cancelled as drawn to non-elected invention. These amendments introduce no new matter.

Claim Rejections Under 35 U.S.C. 102/103(a)

(1) Rejection of Claims 13-16 and 18-22 under 35 U.S.C. §§102(b), 102(a), 102(e) or 103(a) over Zouahri et al.

The Examiner rejected pending claims as anticipated by, or, in the alternative, as being obvious over Zouahri *et al.*, European Polymer Journal 38 (2002) 2247-2254. Without addressing the merits of the rejection, Applicants note that the date of acceptance of Zouahri's publication, March 20, 2002, is after the earliest priority date of the present application, March 5, 2002. As such, Zouahri *et al.* is unavailable as a prior art reference.

Reconsideration and withdrawal of the rejection are respectfully requested.

(2) Rejection of Claims 13-16 and 18-22 under 35 U.S.C. §§102(b), 102(a), 102(e) or 103(a) over U.S. 5,643,968 ("Andreola")

The Examiner rejected the pending claim as anticipated by, or, in the alternative, as being obvious over Andreola. The Examiner stated that Andreola discloses graft copolymer having a backbone of a first polymer and a polymerizable vinyl monomer containing ion exchange functional groups. The Examiner concluded that Andreola describes the product such as would result from practicing the step recited in base Claim 13.

Applicants respectfully direct the Examiner's attention to Andreola, column 2, lines 37-46, in which Andreola describes that the polymerized vinyl or ring compound is grafted onto the first polymer:

The present invention provides ion exchange membranes comprising a soluble graft copolymer comprising a backbone of a first polymer having a main chain containing aromatic rings and at least one polymerized vinyl or

ring compound having ion exchange functionality wherein said polymerized vinyl or ring compound is anionically grafted onto said first polymer on at least one of said aromatic rings or at least one benzylic carbon atom of said aromatic ring, and specific novel graft copolymers are also disclosed. [*Emphasis added.*]

As such, there is only one polymer in the composition of Andreola, namely, the one in which an ion exchange functionality (*i.e.* a charged group) is grafted onto an aromatic backbone.

In contrast, the claimed electrolyte membranes comprise an inter-penetrating network of two independent polymers. Indeed, Claim 13, recites that vinyl-containing phosphonic acid is *polymerized* within already existing polymer (the polymer of step (a)). Furthermore, it is clear from the written description (see, for example, page 6, line 21 of the English translation) that polyvinylphosphonic acid forms an inter-penetrating network with the polymer of step (a). Thus, the material that results from performing the steps recited in Claim 13 is different from the material disclosed by Andreola.

Nor does Andreola render the claimed invention obvious since nothing in Andreola teaches or suggests the use of a mixture or a blend of polymers rather than a single graft polymer.

Reconsideration and withdrawal of the rejection are respectfully requested.

(3) Rejection of Claims 13-16 and 18-22 under 35 U.S.C. §§102(b), 102(a), 102(e) or 103(a) over U.S. 6,607,856 ("Suzuki")

The Examiner rejected the pending claims as anticipated by, or, in the alternative, as being obvious over Suzuki. The Examiner stated that Suzuki discloses a solid polymer electrolyte membrane containing backbone polymer having functional chelate groups such as phosphonic acid groups. The Examiner further stated that the membrane of Suzuki possesses proton-conductivity of greater than 0.01 S/cm. The Examiner concluded that the membrane of Suzuki is the same as the membrane claimed in Claim 13 of the instant application.

Applicants disagree with the Examiner's interpretation of Suzuki and with the Examiner's conclusion.

Suzuki teaches that a first polymer (ETFE-g-PSt) is doped with a second polymer (polyvinylphosphonic acid). The process of Suzuki includes a step in which long polymeric

chains of polyvinylphosphonic acid are mixed (see, e.g. Example 1, column 9, lines 45-55). Although Suzuki does use the term “interpenetrating polymer network”, one of ordinary skill in the art of polymer science will appreciate that forming an interpenetrating network from two different polymers runs against steric, electrostatic and other physical limitations inherent in trying to thread polymer chains through one another.

In contrast, Claim 13, defines a membrane that is manufactured by (a) *expanding* a polymer film with liquid that contains vinyl-phosphonic acid, and (b) *polymerizing* vinyl-containing phosphonic acid. In other words, Claim 13 defines a membrane produced by imbuing a first polymer with vinyl-phosphonic acid *monomer*, followed by *in situ* polymerization of vinyl-phosphonic acid within the first polymer. Furthermore, it is clear from the term “expanding” in Claim 13 that monomers of vinyl-containing phosphonic acid are concentrated throughout the volume of the polymer film. Applicants also note that Claim 14 expressly stipulates that the polymer film of step (a) increased its volume (“expanded”) by at least 3% due to concentration by the liquid containing phosphonic acid monomers throughout the polymer.

One of ordinary skill in the art will appreciate that a material prepared by the process claimed in Claim 13, the process that includes *in situ* polymerization of a monomer that was allowed to concentrate throughout the volume of a pre-existing polymer matrix, will produce a material having much higher degree of interpenetration of two types of polymer chains than a material produced by allowing one type of polymer chains to diffuse through another type. Thus, the membranes of Claim 13 are materially different from membranes prepared by the method of Suzuki. Accordingly, Applicants submit that Suzuki fails to anticipate Claim 13.

Nor does Suzuki render the claimed invention obvious. First, nothing in Suzuki teaches or suggests the use of *in situ* polymerization of monomer within a polymer matrix. Furthermore, Applicants’ membranes possess unexpected advantages not disclosed or suggested by Suzuki. Specifically, Applicants’ membranes show conductivity at very high temperatures, above the boiling point of water, and thus can function without moistening. (See page 5, lines 29-31, and the paragraph bridging pages 5 and 6 of the English translation of the instant Application). In fact, the Applicants’ membranes retain conductivity at 160 °C, at which temperature no water is present (see Tables in Examples 1-27, pages 40-50, which show that various embodiments of the membranes of the present invention possess high conductivity at 160 °C). This is to be

contrasted with the materials of Suzuki, which only show conductivity in the presence of water. See Suzuki, column 14, lines 29-40.

Reconsideration and withdrawal of the rejection are respectfully requested.

(4) Rejection of Claims 13-16 and 18-22 under 35 U.S.C. §§102(b), 102(a), 102(e) or 103(a) over U.S. 6,248,469 ("Formato")

The Examiner rejected the pending claims as anticipated by, or, in the alternative, as being obvious over Formato. The Examiner stated that Formato discloses a solid polymer electrolyte membrane having porous polymer substrate interpenetrated with ion-conducting material. The Examiner also stated that one of the methods of producing the membranes if Formato comprises the step of preparing the substrate polymer, impregnating the substrate with a monomer, and polymerizing the monomer *in situ* to form the composite membrane.

Applicants submit that the substrate polymer of Formato is materially different from the polymer film of step (a) of Applicants' Claim 13, and that, therefore, the composite membranes resulting from the methods of manufacturing described by Formato are also materially different from the membrane of Claim 13.

Applicants direct Examiner's attention to column 12, lines 28-47 of Formato, where the general method of preparation of his membranes is described. Specifically, the substrate polymer is formed into film (col. 12, lines 33-36), and then immersed in water, which leaches out solvent and coagulates polymer (col. 12, lines 36-39). This process forms voids (col. 12, line 40). Ion-conducting material is then introduced into these voids either by solvent-exchange process (column 12, lines 41-42), or by infiltrating a dry membrane (column 12, line 43). This description is consistent with FIG. 1, which is a schematic illustration of the process by which Formato's membranes are prepared. (Applicants note that express description of FIG. 1 is not found in Formato.) It is clear from panel A of FIG. 1 that micropore regions (*i.e.* the regions in which "voids" were formed by solvent leaching) are separate and distinct from polymer regions (*i.e.* regions in which no "voids" were formed). Turning now to panel B of FIG. 1, it is clear that whether solvent-exchange or infiltration variant of the process of Formato is used, the ion-conducting material is in the micropore regions, and not into the polymer regions. (Applicants

particularly note that the two types of regions are expressly marked by different labels in panel C of FIG. 1.)

Thus, the membrane of Formato, even if prepared by employing *in situ* polymerization of the ion-conducting material, will have bulk regions in which little or no ion-conducting material will be present. This is to be contrasted with the membranes of the present invention, which are not taught to contain voids, or micropores. This is because no leaching of solvent by water, as described by Formato, is performed. Instead, a polymer film of step (a) of Claim 13 is expanded, *i.e.* imbued, with liquid solution of vinylphosphonic acid, which is then polymerized *in situ*, forming inter-penetrating network (see page 6, lines 19-21 of the English translation of the instant application). As a result, the membranes of the present invention lack bulk regions of the polymer substrate from which ion-conducting material is absent (such as “substrate polymer regions” shown in panel C of FIG. 1 of Formato). Accordingly, the membranes of Claim 13 are materially different from those of Formato.

Nor does Formato render the render Claim 13 obvious. Formato’s invention relies on filling the micropores in the substrate polymer with ion-conducting material. Thus, Formato neither teaches nor suggests any other method of interpenetrating one polymer with another, ion-conducting, polymer. Furthermore, as Applicants argued with respect to Suzuki, above, Applicants’ membranes possess unexpected advantages not disclosed or suggested by any of the cited references, including Formato. Specifically, Applicants’ membranes show conductivity at very high temperatures, above the boiling point of water, and thus can function without moistening. (See page 5, lines 29-31, and the paragraph bridging pages 5 and 6 of the English translation of the instant Application).

Reconsideration and withdrawal of the rejection are respectfully requested.

CONCLUSION

In view of the above remarks, it is believed that all claims are in condition for allowance, and it is respectfully requested that the application be passed to issue. If the Examiner feels that a telephone conference would expedite prosecution of this case, the Examiner is invited to call the undersigned.

Respectfully submitted,

HAMILTON, BROOK, SMITH & REYNOLDS,
P.C.

By 

Alexander Akhiezer

Registration No. 54,617

Telephone: (978) 341-0036

Facsimile: (978) 341-0136

Concord, MA 01742-9133

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